

REMARKS

The Applicants request reconsideration of the rejection.

Claims 1, 4-7 and 10-14 remain pending.

Rejection of Claims under 35 USC § 112

Claims 1, 3-7 and 9-14 stand rejected under 35 USC § 112, second paragraph, as being indefinite in that claims 1 and 7 use the term "large number" and claims 5 and 11 use the term "small enough".

Claims 1 and 7 have been amended to delete the term "large number" and claims 5 and 11 have been amended to delete the term "small enough". It is therefore submitted that these claims are now definite and satisfy all requirements of 35 USC § 112.

Rejection of Claims under 35 § 103(a)

Claims 1, 3-7 and 9-14 stand rejected under 35 § 103(a) as being unpatentable over Akita et al. U.S. Patent 5,490,730 in view of Pacholke U.S. Patent 4,715,972.

For the reasons set forth hereafter, it is submitted that remaining claims 1, 4-7 and 10-14, as amended, are patentable.

Patentability of Claims 1, 4-7 and 10-14

With respect to the rejection under 35 USC § 103 (a) of claims 1-4 as being unpatentable over Akita et al. U.S. Patent 5,490,730 in view of Pacholke U.S. Patent 4,715,972, Applicants respectfully traverse this rejection for the following reasons.

Akita et al. U.S. Patent 4,490,730 is a U.S. counterpart of Japanese Patent No. 2832800 disclosed in the description of the present application as prior art. The problems of the technology in Akita et al., as well as the solution therefore in the present invention and the effect and advantages thereof are stated on pages 2 to 5 of the description of the present application. As discussed hereafter, the present invention is a significant patentable improvement over Akita '730, taken either alone or in combination with Pacholke '972.

The essential feature of the present invention resides in that the bushing is impregnated with a lubricant containing 2.0 to 30 wt% of solid lubricating fine particles made of at least one selected from among MoS₂, WS₂, and hexagonal BN. Claim 1 further calls for the shaft 22 and bushing 16 to be used at a surface pressure not lower than 6kgf/mm² and a sliding speed in the range of 2 to 5 cm/sec. Moreover, claim 1 has been amended to recite that the viscosity of the lubricant 24 containing the solid lubricating particles (26) is in the range of 56 to 1500 cSt at 25.5°C. Claim 7 has been similarly amended.

In the Office Action, the Examiner states that though Akita does not disclose the specific range of 2 to 30 wt% of the solid lubricating fine particles, the selection of such a specific range is well within the skill of the artisan as taught by Pacholke US. Patent 4,715,972. The numerical limitation of the content of solid lubricating fine particles in claim 1 of the present invention, however, was determined by the present inventors only after conducting various tests, obtaining data as shown in Figures 3 and 4 and studying and considering such data as explained in the description at page 14, line 2 to page 15, line 10 with reference to Figures 3 and 4, and thus is not well within the skill of the artisan in view of the teachings of '972.

More specifically, concerning the lower limit of "2.0 wt%" in the content of solid lubricating fine particles, the description of the present application explains as follows at pages 14, lines 7-20:

"As shown in Fig. 3, when the lubricant containing 1.5% of MoS₂ is used, the load withstand characteristic is slightly reduced in comparison with the case using only the lubricant. However, when the content of MoS₂ is set to 2.0%, the load withstand characteristic is increased in comparison with the case using only the lubricant. When the content of MoS₂ is increased to 3.0 - 5.0%, the load withstand characteristic is further increased. When the content of MoS₂ exceeds 10%, the coefficient of friction is hardly changed even when pressure is increased to 10 MPa, and the load withstand characteristic can be significantly increased. Accordingly, a lower limit of MoS₂ content is preferably set to 2.0% at which the effect of improving the load withstand characteristic is practically obtainable."

Further, concerning the upper limit of "30 wt%" in the content of solid lubrication fine particles, the description of the present application states as follows at page 14, line 24 to page 15, line 10:

"As shown in Fig. 4, when the content of MoS₂ is set to 20%, the lubricant viscosity increases to about 1500 cSt (at 25.5°C). When the content of MoS₂ exceeds 30%, the lubricant viscosity becomes larger than 1500 cSt. In general, if the lubricant viscosity exceeds 1500 cSt, the fluidity of the lubricant is reduced and a difficulty arises in making the porous sintered ally impregnated with

the lubricant. In addition, as described above, a capillary phenomenon acting to return the lubricant having seeped out onto the sliding surface with generated frictional heat onto the pores of the bushing 16 again is less likely to occur, which gives rise to a risk of reduction in bearing performance. Accordingly, an upper limit of the MoS₂ content is preferably set to 30% at which the viscosity of the lubricant containing MoS₂ is not larger than about 1500 cSt."

As mentioned above, the numerical limitation of "30 wt%" as the upper limit for the content of solid lubrication fine particles has a close relationship with the viscosity of the lubricant containing the solid lubrication fine particles, and therefore, in the amendments of the claims, the limitation of the viscosity of the lubricant was added for clarification of this point.

Pacholke '972 relates to a solid lubrication additive for gear oils and discloses that the final selection of a level of the content of solid lubrication particles in gear oils is well within the skill of the artisan in column 4, line 61-66, for example. The technology of Pacholke, however, is directed to the selection of a level of the content of solid lubrication particles in gear oils, but does not relate to the selection of a level of the content of solid lubrication fine particles in a lubricant with which a bushing is impregnated as in the present invention.

In the present invention, the numerical limitation of the content of solid lubrication fine particles was attained only as a result of studying and considering the relationship between the pressure and the coefficient of friction (withstand characteristic) as shown in Figure 3 as well as the relationship between the content

of solid lubrication fine particles (MoS_2) and the viscosity of the lubricant as shown in Figure 4 when the bushing made of a porous sintered material is impregnated with solid lubrication fine particles such as MoS_2 . Such a result is a unique characteristic in a case where a bushing made of a porous sintered material is impregnated with solid lubrication fine particles such as MoS_2 , and is not in a case where solid lubricant particles are added in gear oils.

Accordingly, the features of the numerical limitation of the content of solid lubrication fine particles in the present invention are not considered to be well within the skill of the artisan, as opposed to the case where the level of the content of solid lubrication particles in gear oils is selected as in Pacholke '972, and therefore such features of the present invention are not considered obvious from the teachings of Pacholke.

Further, with such features, the present invention can achieve the advantages that a superior effect of improving the load withstand characteristic can be obtained while suppressing an increase of viscosity of the lubricant, and consequently, even under a situation of sliding at a very low speed or angular motion in a very small stroke, it is possible not only to suppress local abrasion or damage of the surface of the shaft and the inner circumferential surface of the bushing caused by scratching, etc. and accompanying abnormal noise, but also to prolong the period during which sliding operation can be continued in the oil-less self-lubricating state.

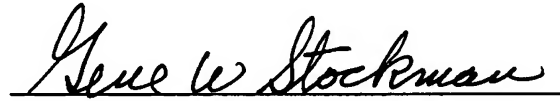
Accordingly, it is believed that claims 1 and 7, as amended, as well as the claims dependent therefrom are patentable over Akita et al., in view of Pacholke.

In view of the foregoing amendments and remarks, the Applicants request reconsideration of the rejection and allowance of the claims.

To the extent necessary, the Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, or credit any overpayment of fees, to the deposit account of Mattingly, Stanger, Malur & Brundidge, P.C., Deposit Account No. 50-1417 (referencing attorney docket no. KAS-241).

Respectfully submitted,

MATTINGLY, STANGER, MALUR & BRUNDIDGE, P.C.

A handwritten signature in cursive script, reading "Gene W. Stockman", written over a horizontal line.

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